



UNIWERSYTET MEDYCZNY  
IM. PIASTÓW ŚLĄSKICH WE WROCŁAWIU

**Subject:** Microbiology (1)

**Topic:** Introduction to clinical microbiology Bacterial morphology

Academic year 2023/2024

These educational materials are protected following the Act of February 4, 1994, on copyright and related rights. Their distribution and use other than for educational purposes of students of the Piast Silesian Medical University in Wrocław is prohibited.

Wydział: Lekarski  
Kierunek: Lekarski  
Poziom studiów (jedn. mgr.)  
Forma studiów (stacjonarne,  
niestacjonarne)  
Rok studiów: II

Tytuł naukowy/zawodowy: prof. dr hab.  
Imię, nazwisko osoby prowadzącej zajęcia: Beata Sobieszcańska  
Stanowisko osoby prowadzącej zajęcia: profesor  
Uniwersytet Medyczny im. Piastów Śląskich we Wrocławiu  
Copyright ©

# Important information: Microbiology (1)

- Textbook: MICROBIOLOGY P. R. Murray, K.S. Rosenthal, M.A. Pfaller
- Classes: online lectures (presentations on the Department's website + lecture repository)
- On the Department's website: [REGULATIONS FOR MICROBIOLOGY CLASSES](#) - please read!!!
- Class tests - written tests (10 open questions): two dates - first and re-sit;
- For students who do not pass the class test, a final test at the end of the semester covering the entire material
- Materials for students (to be printed from the Department's website) must be completed during the lecture (also from the textbook) and be supplemented during classes
- Passing each class: oral answer (or taking the material from the class with the teacher) - passing all classes is a condition for passing the course. There are no grades for completing the exercises
- The scope of material required for tests and exams in the second year - in the class schedule on the website of the Department of Microbiology

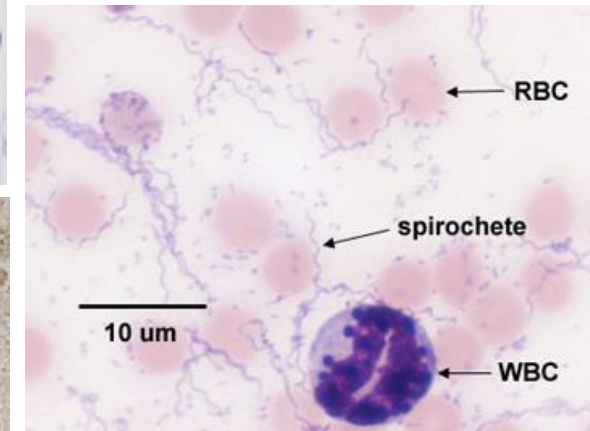
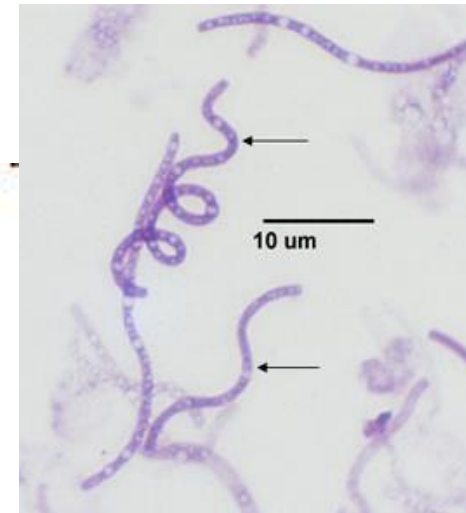
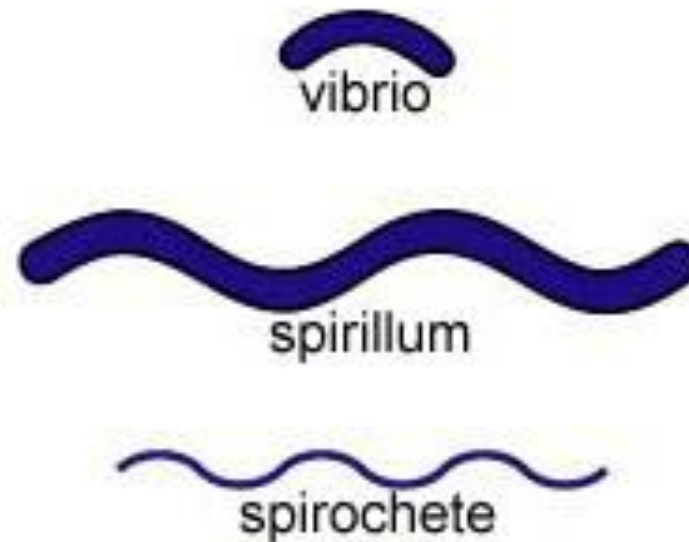
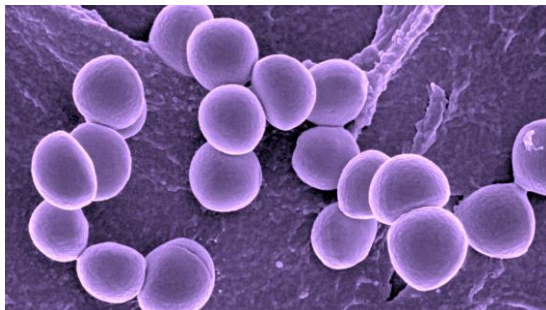
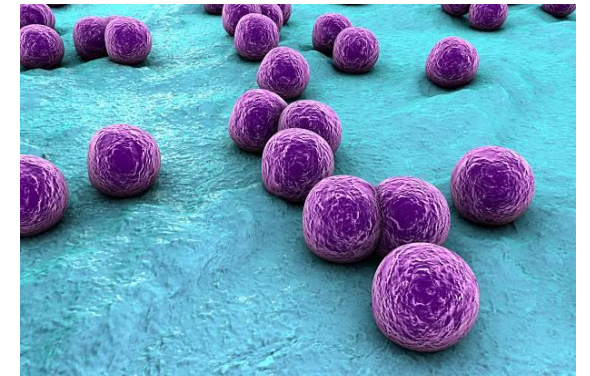
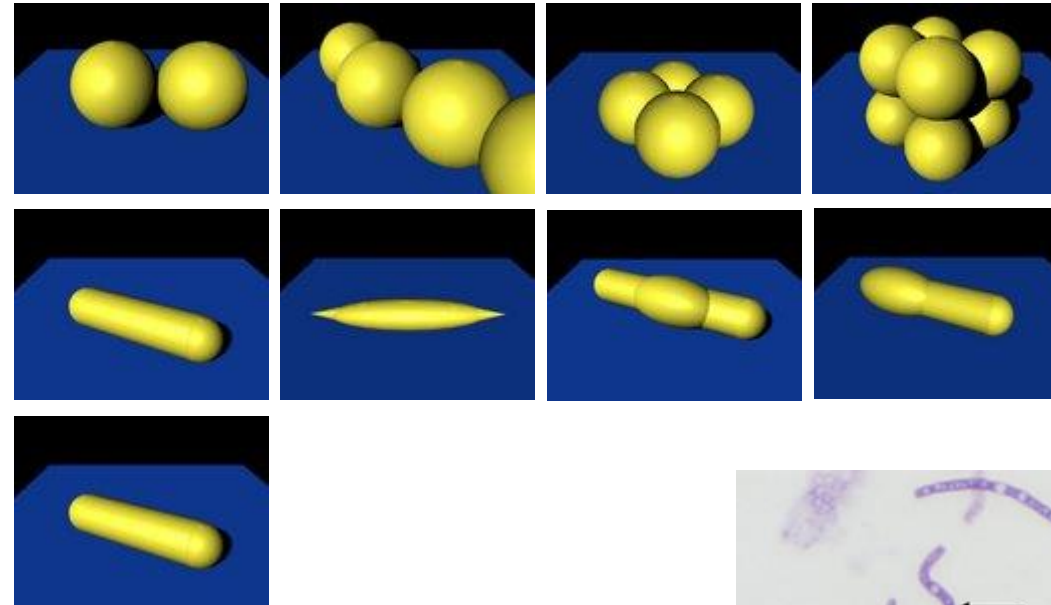
## Microbiological dictionary

- **Microorganism** - an organism invisible to the naked eye (bacteria, viruses, fungi, parasites)
- **Pathogenicity** - the ability of a microorganism to cause disease - **PATHOGEN**
- **Virulence** - the ability of a microorganism to damage host cells and tissues - **VIRULENCE FACTOR**
- **Host** - a higher organism in which the microorganism multiplies (human, animal)
- **Routes of transmission** - air: droplets, aerosol, contact: direct, indirect, oral, fecal-oral, vector (arthropods), parenteral (blood-borne)
- **Microbial reservoir** - the environment in which the microorganism typically develops (soil, water, human body, animal body) - may, but does not have to be, a source of infection
- **Source of infection** - a person, animal, food, object, or other factor from which the microorganism is transferred directly to sensitive people
- **Carrier** - a person "carrying" a pathogenic microorganism that does not cause symptoms of the disease - is a source of infection for susceptible people
- **Microbiota** - a set of microorganisms that colonize the human body under physiological conditions

# Clinical/medical microbiology

- **Endogenous vs. exogenous** infection: infection with a microorganism (pathogen) from an external source vs. a disease caused by bacteria that naturally colonize the human body
- **Opportunistic infection**: infections caused by microorganisms that use the opportunity to spread throughout the human body (e.g. weakened immunity) or invade sterile tissues (e.g. wound), where they cause infection (inflammation)
- **Non-specific prevention**: non-specific measures to prevent infections with various microorganisms, e.g. hand washing
- **Specific prevention**: specific measures to prevent a specific infection (vaccines, chemoprophylaxis)
- **Anatoxin (toxoid)**: inactive bacterial toxin (often a component of vaccines)
- **Anti-toxin**: antibody against a specific toxin
- **Toxemia**: presence of a bacterial toxin in the body (e.g., blood, intestines)
- **Antigenemia**: the presence of antigens (usually virulence factors) of microorganisms in the blood
- **Bacteremia, viremia, fungemia**: the presence of bacteria, viruses, fungi in the blood
- **Vaccine antigens**: live, attenuated microorganisms, toxoids, subunit, vaccine DNA

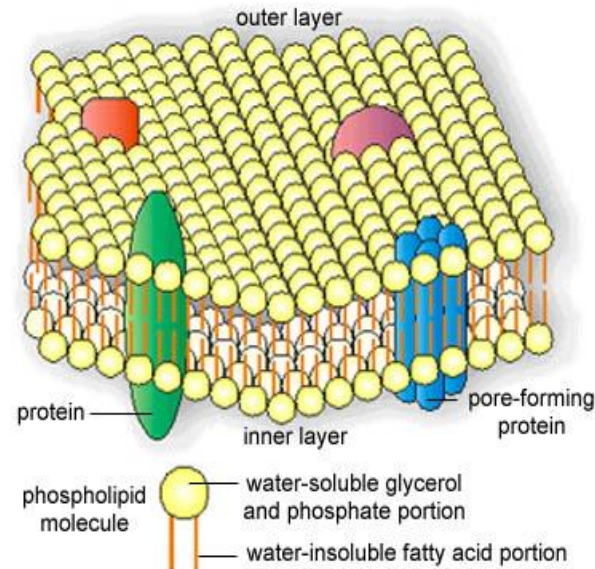
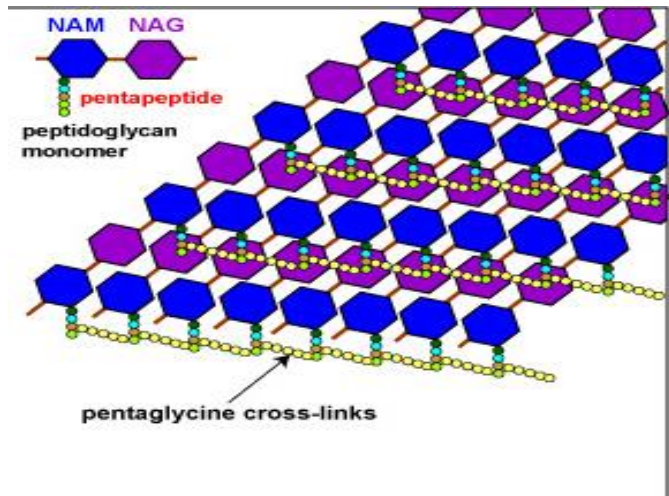
Shape  
 → Cocci  
 → Rods  
 → Bacilli  
 → Spiral



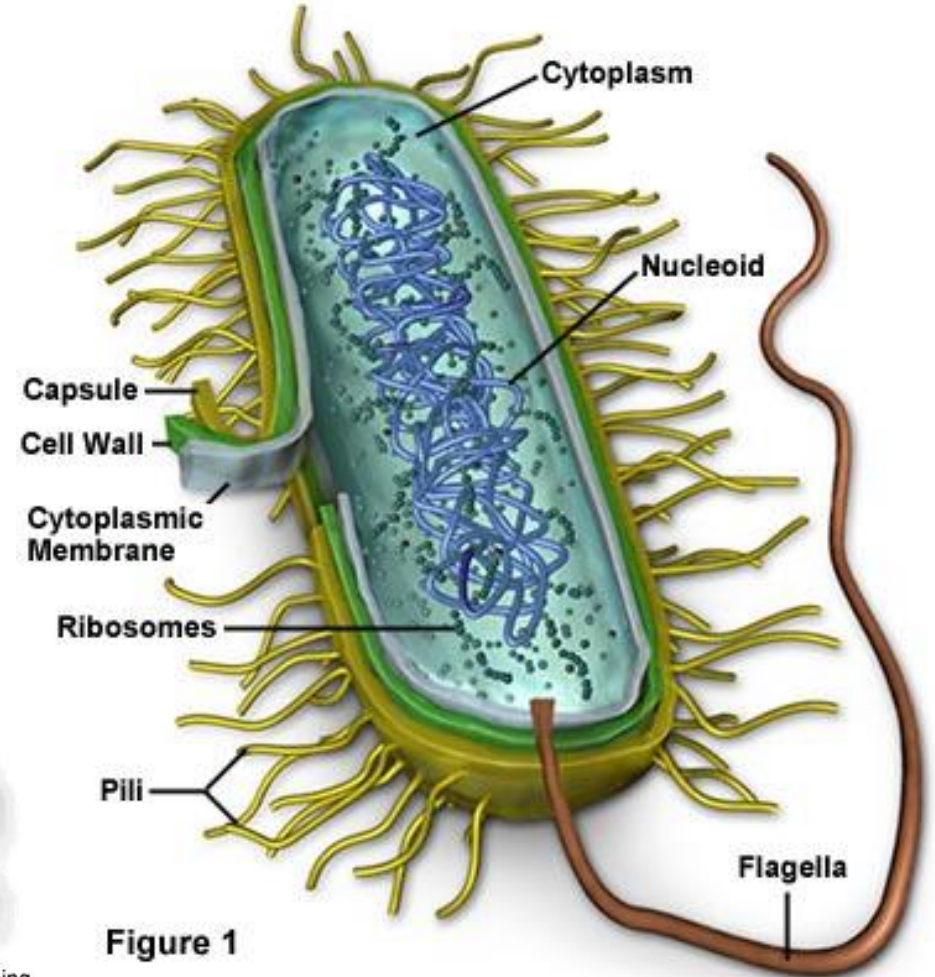


# The structure of a bacterial cell

- Single-celled, reproduces by division, haploid
- Cell nucleus - DNA; lack of nucleolus
- Ribosomes; no mitochondria
- Cytoplasmic membrane surrounded by a cell wall, sometimes additionally a capsule (polysaccharide, protein)
- Cell wall (**peptidoglycan**) - gives shape
- Fimbriae, surface proteins - adhesion
- Cilia - movement (taxis)



**Prokaryotic Cell Structure**



**Figure 1**

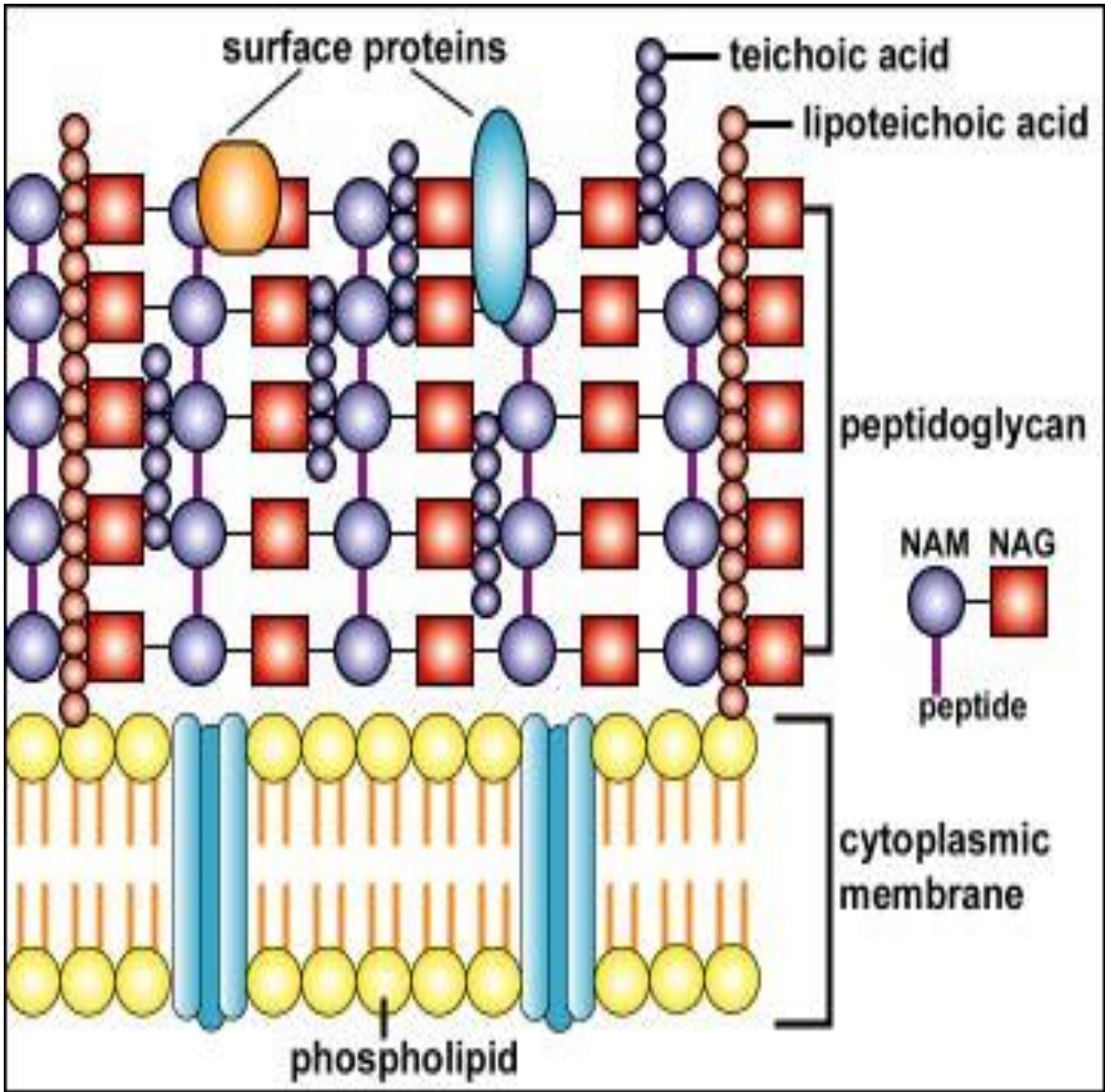
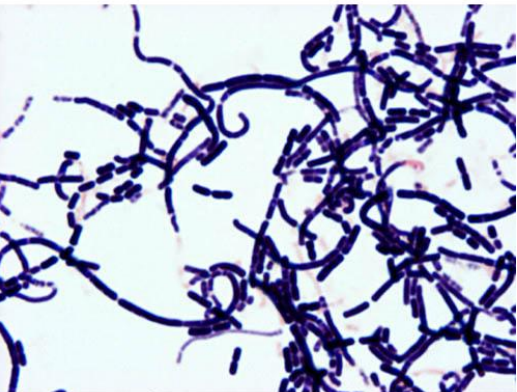
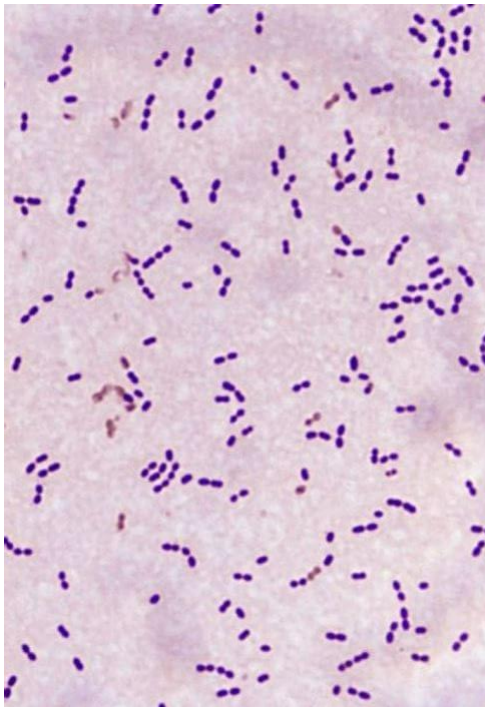
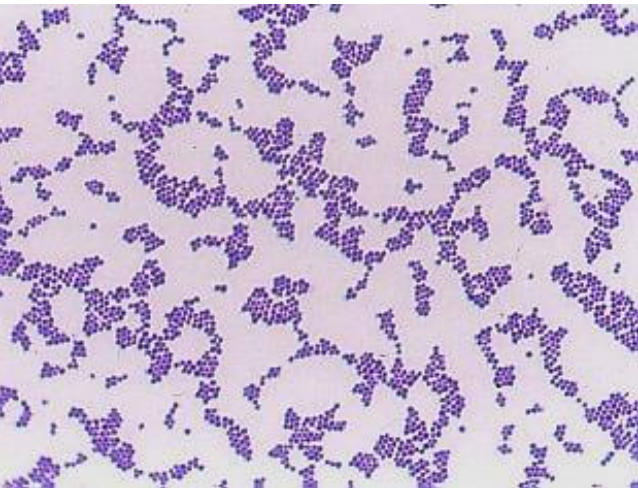


# Gram-positive (GP) bacteria

Purple in Gram staining

Examples:

- Streptococcus
- Staphylococcus
- Clostridium



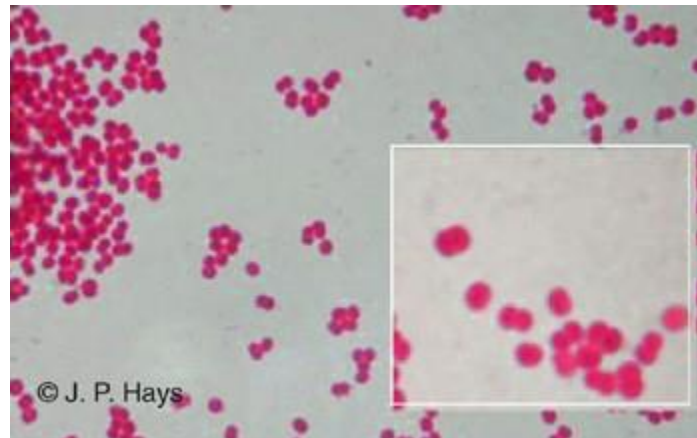
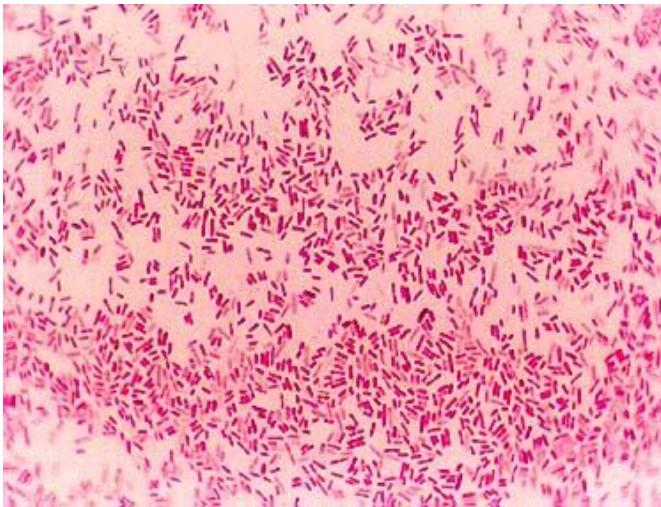


# Gram-negative (GN) bacteria

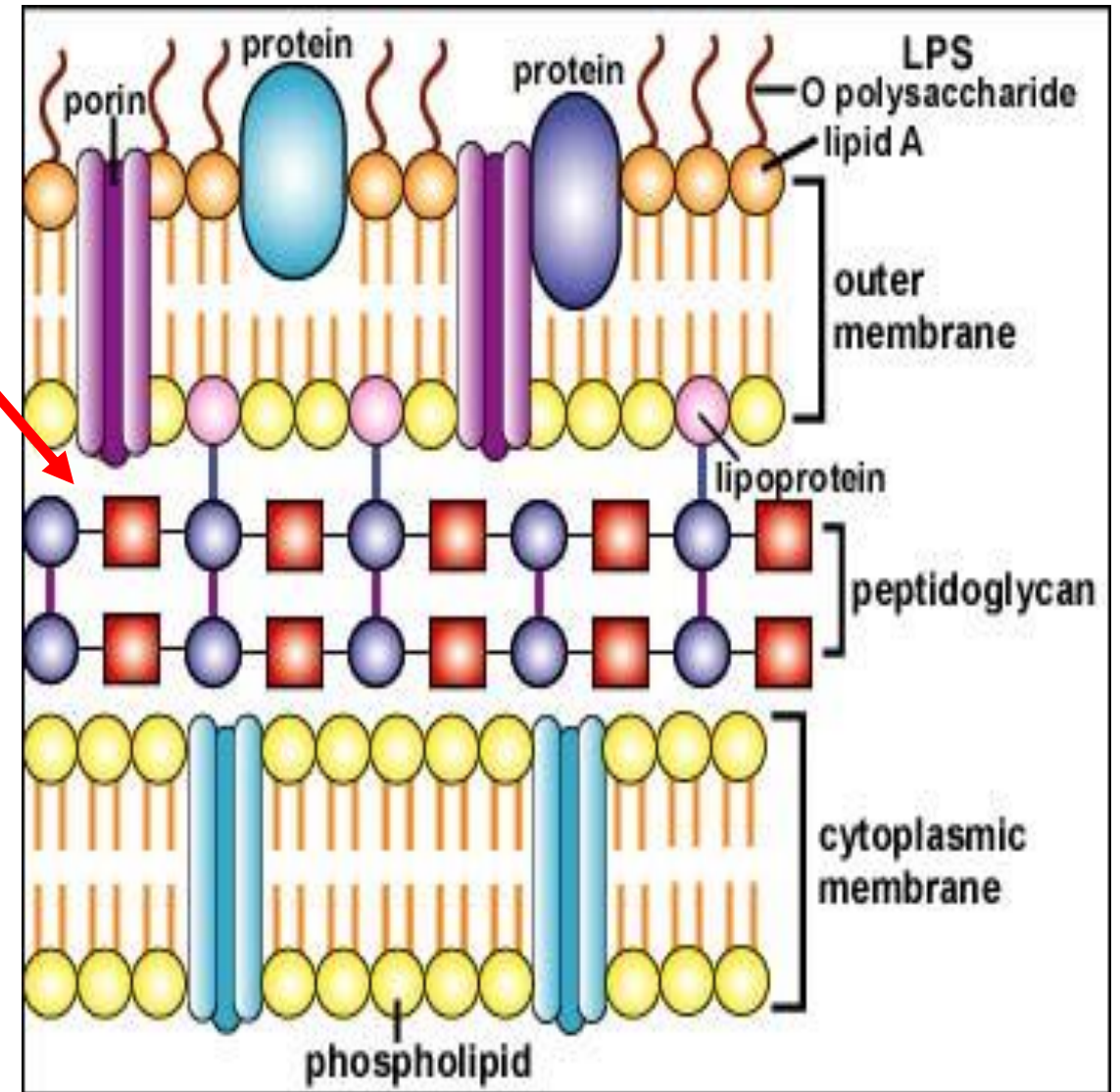
Red in Gram staining

Examples:

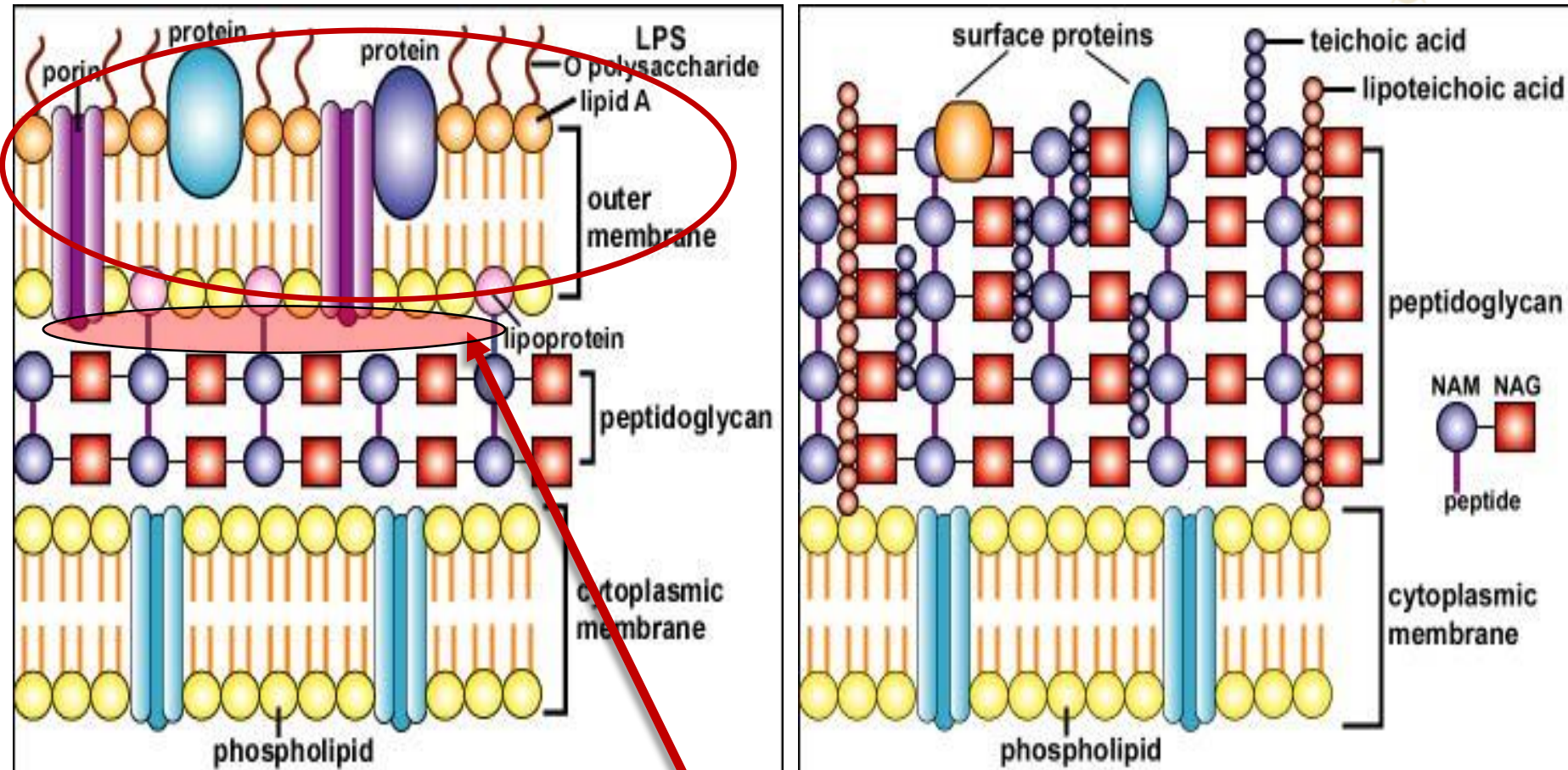
Salmonella, Shigella,  
Escherichia, Pseudomonas



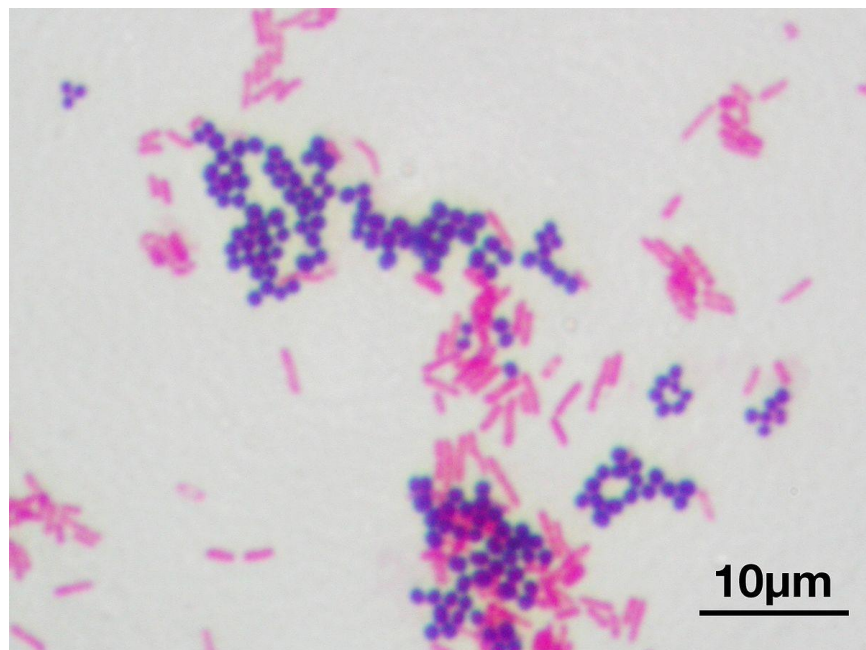
Periplasmic space







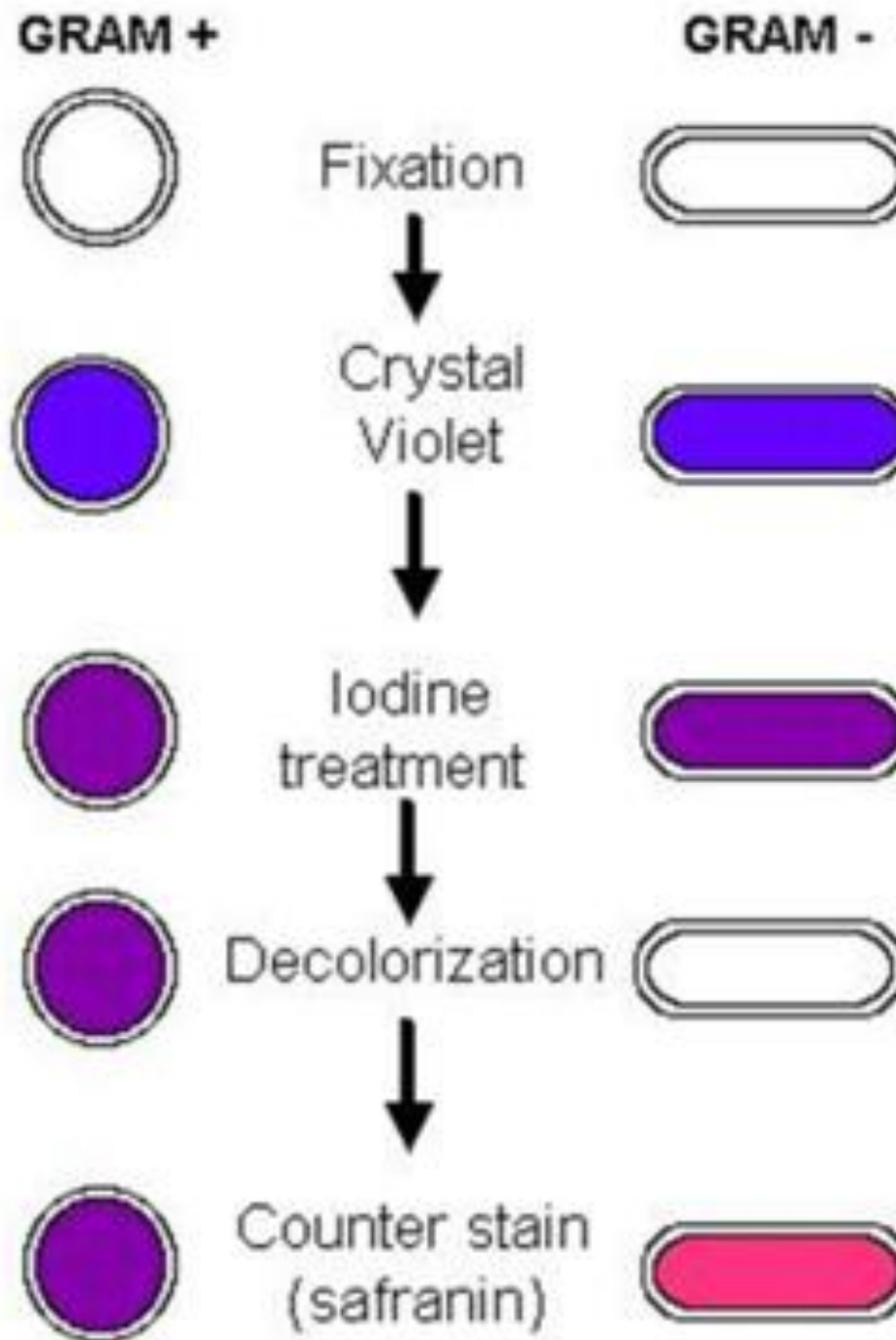
**Periplasmic space** filled with water  
 Storage of enzymes, toxins



Native, vital preparation (live bacteria) vs fixed (bacteria killed)

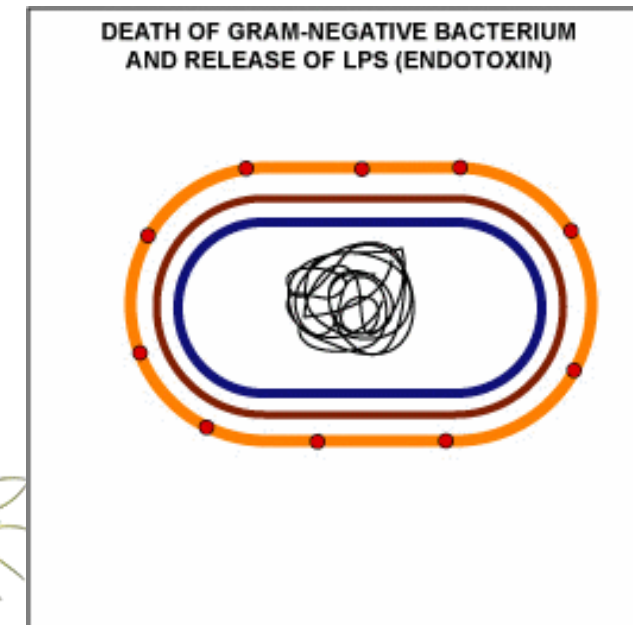
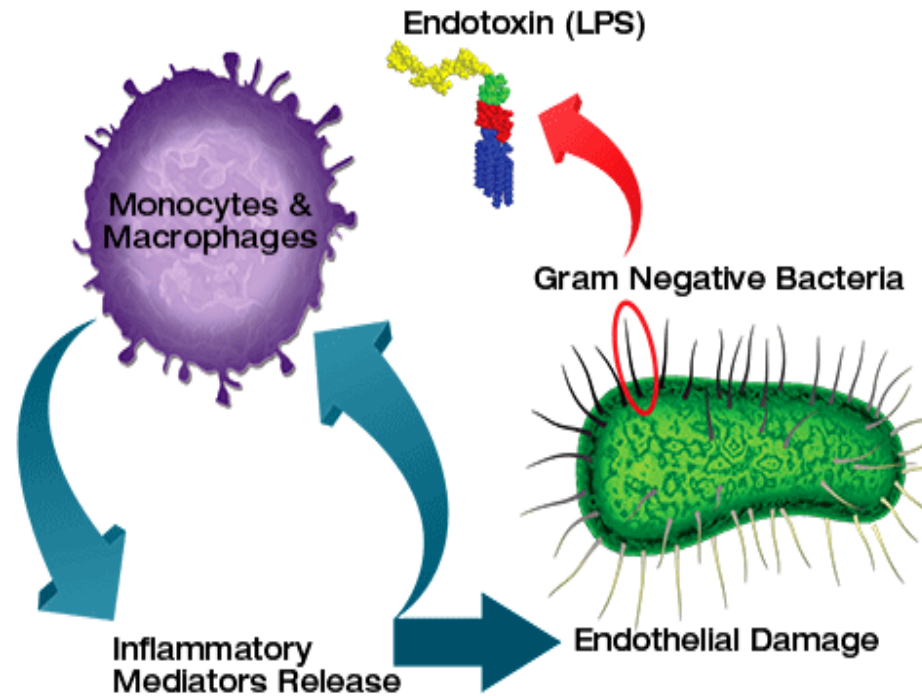
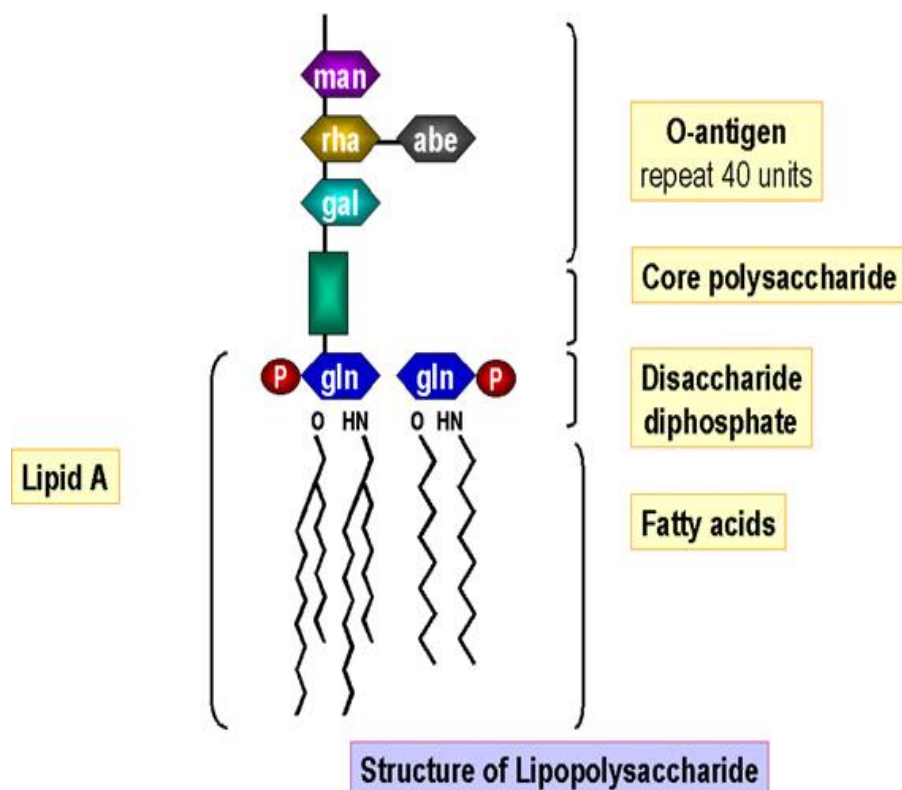
### Why is it important?

The selection of antibiotics for treatment depends on the structure of the cell wall (GP vs GN) and oxygen demand (aerobic vs anaerobic)



# Important bacterial cell wall antigens

- GP bacteria - lipoteichoic acids (LTA)
- GN bacteria - LPS (endotoxin = lipid A, somatic antigen O), antigen H (ciliary protein), capsular antigen K
- O, K & H antigens - serotyping: E. coli O157:H7 or E. coli K1 = capsule





## Gram-positive (GP) bacteria

### Cocci

#### Aerobic

Staphylococcus  
Streptococcus  
Enterococcus

#### Anaerobic

Peptostreptococcus

### Rods

#### Aerobic

Listeria  
Corynebacterium

#### Anaerobic

Actinomyces  
Cutibacterium

### Bacilli

#### Aerobic

Bacillus

#### Anaerobic

Clostridium

## Gram-negative (GN) bacteria

### Cocci

#### Aerobic

Neisseria  
Moraxella

#### Anaerobic

Veilonella

### Coccobacilli

#### Aerobic

Haemophilus  
Bordetella  
Brucella  
Francisella  
Pasteurella

### Rods

#### Aerobic

**Fermenting:**  
Escherichia  
Klebsiella  
Proteus  
Enterobacter  
Serratia  
Salmonella  
Shigella  
Yersinia

**Nonfermenting:**  
Pseudomonas  
Acinetobacter  
Burkholderia  
Stenotrophomonas

#### Anaerobic

Bacteroides  
Prevotella  
Porphyromonas

### Acid-fast

Mycobacterium  
Nocardia

### Spiral

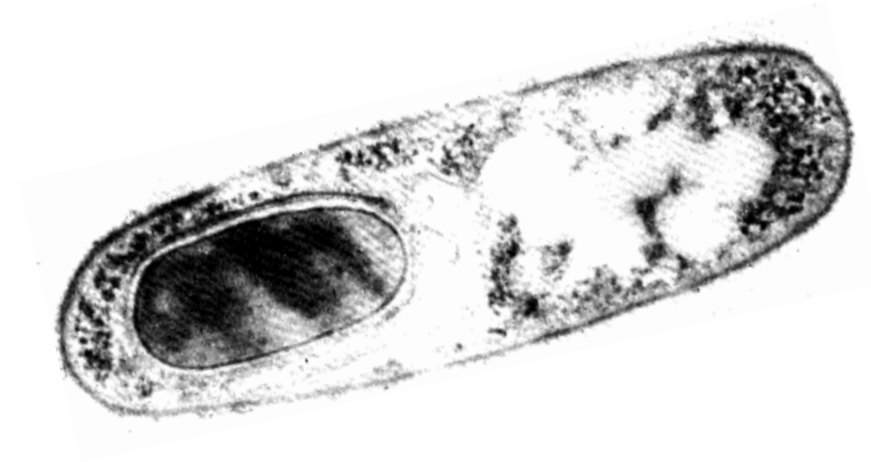
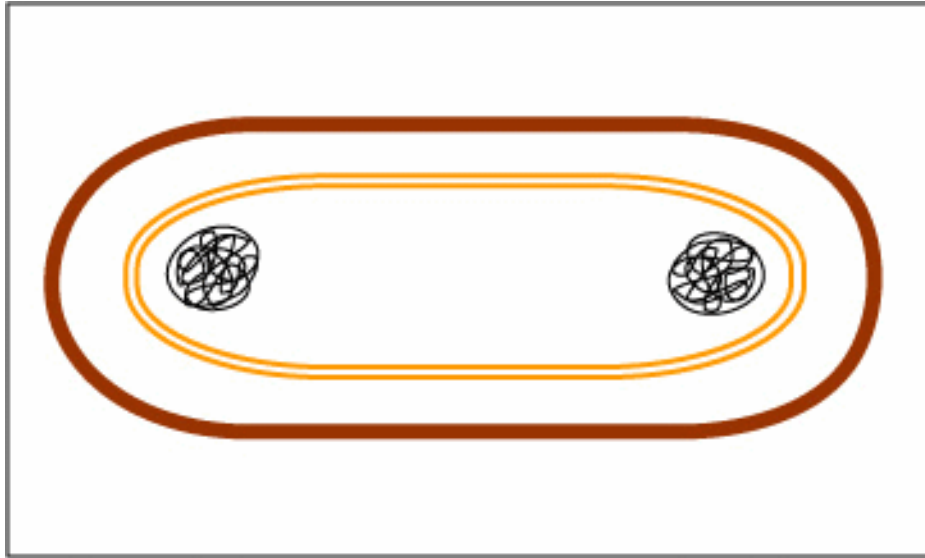
Campylobacter  
Vibrio  
Helicobacter  
Aeromonas

Treponema  
Leptospira  
Borrelia

Weakly/non-staining with Gram  
technique

Legionella, Mycoplasma, Chlamydia,  
bakterie spiralne

## Endospores: Clostridium and Bacillus

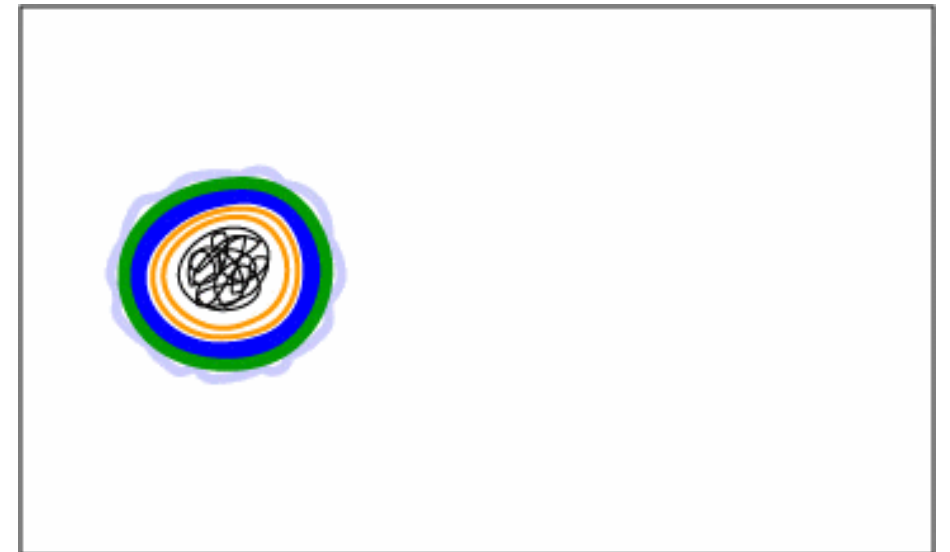


Spore germination

Much smaller than bacteria, challenging to eradicate =  
**dangerous**

**Role:** long-term survival in unfavorable conditions  
(resistant to antibiotics, disinfectants, UV)

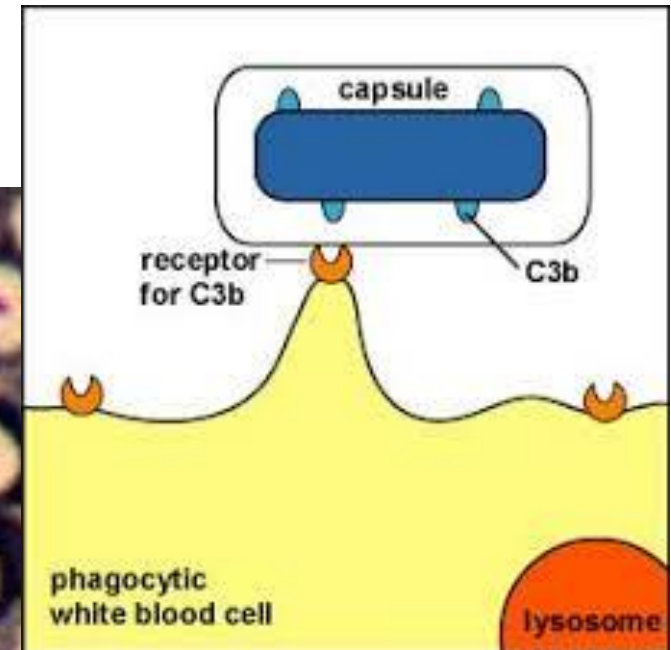
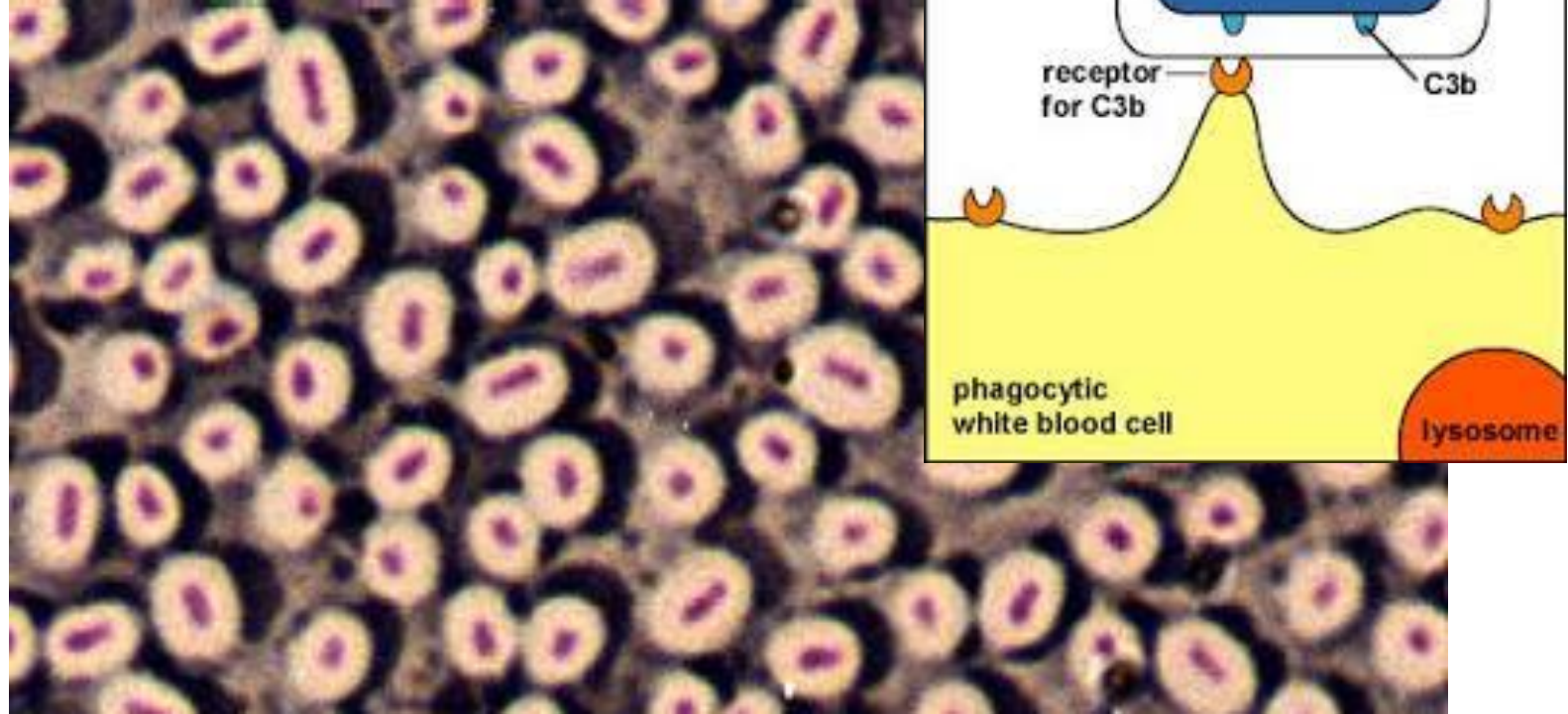
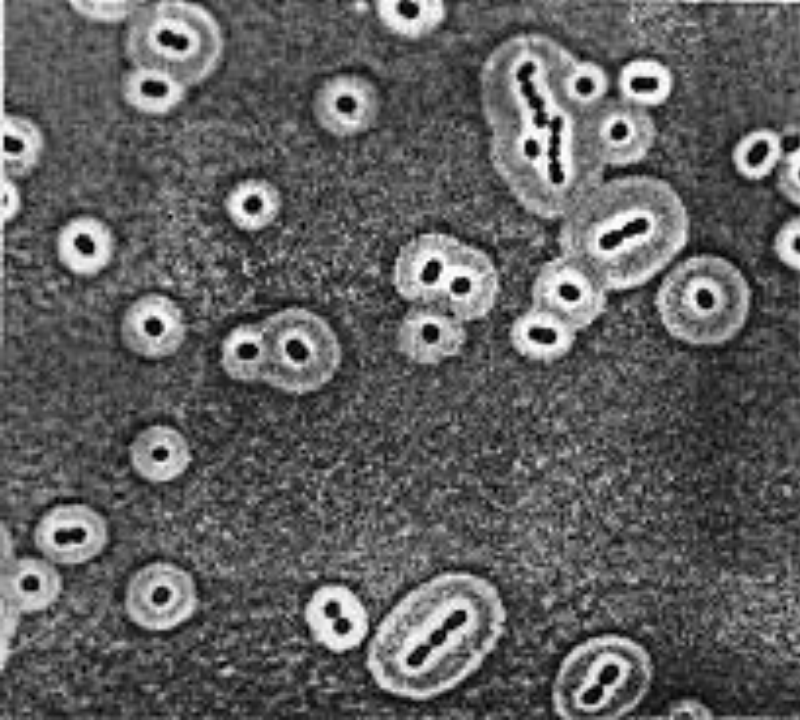
An important role in hospital infections, e.g., post-antibiotic diarrhea



# Surface structures

- a) **Glycocalyx** - a sticky, thin polysaccharide or polypeptide layer of mucus (GP cocci: staphylococci and streptococci) - role in adhesion
- b) **Capsule** - Surrounding - sticky, thick polysaccharide layer - role in masking surface antigens = defense against immune system cells

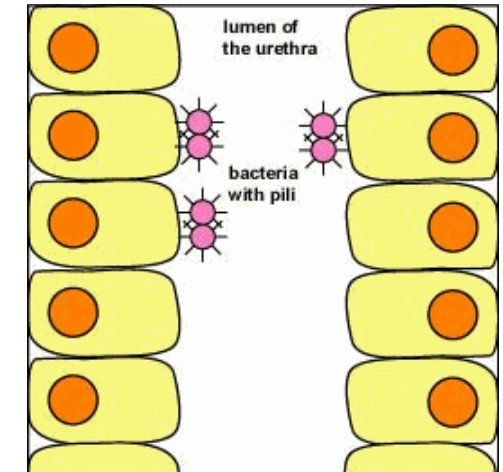
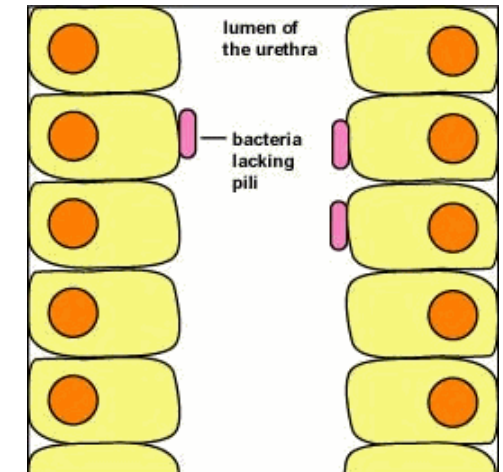
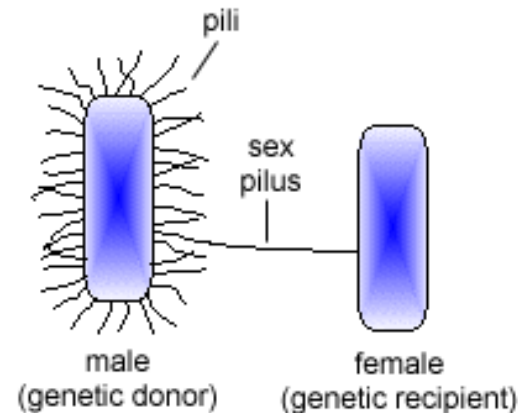
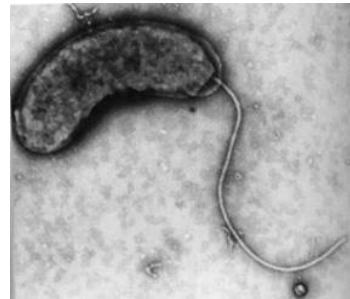
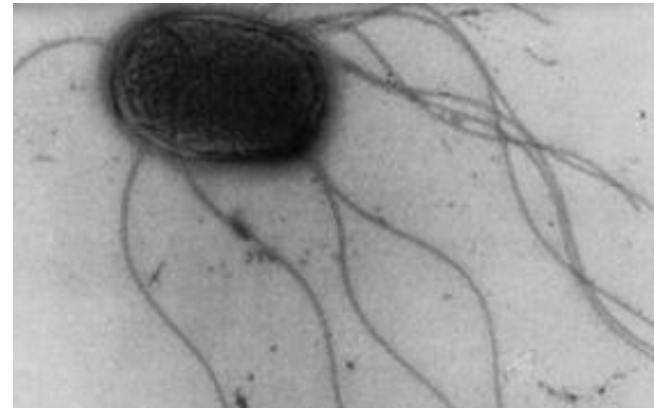
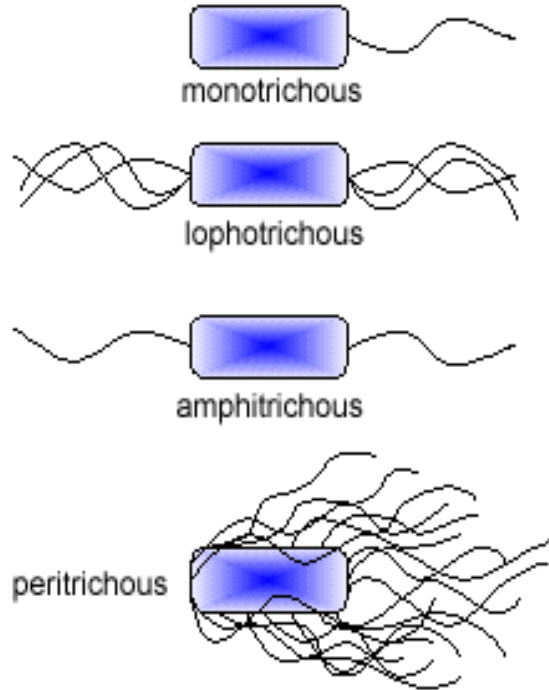
Positive-negative staining (ink + Gram staining)



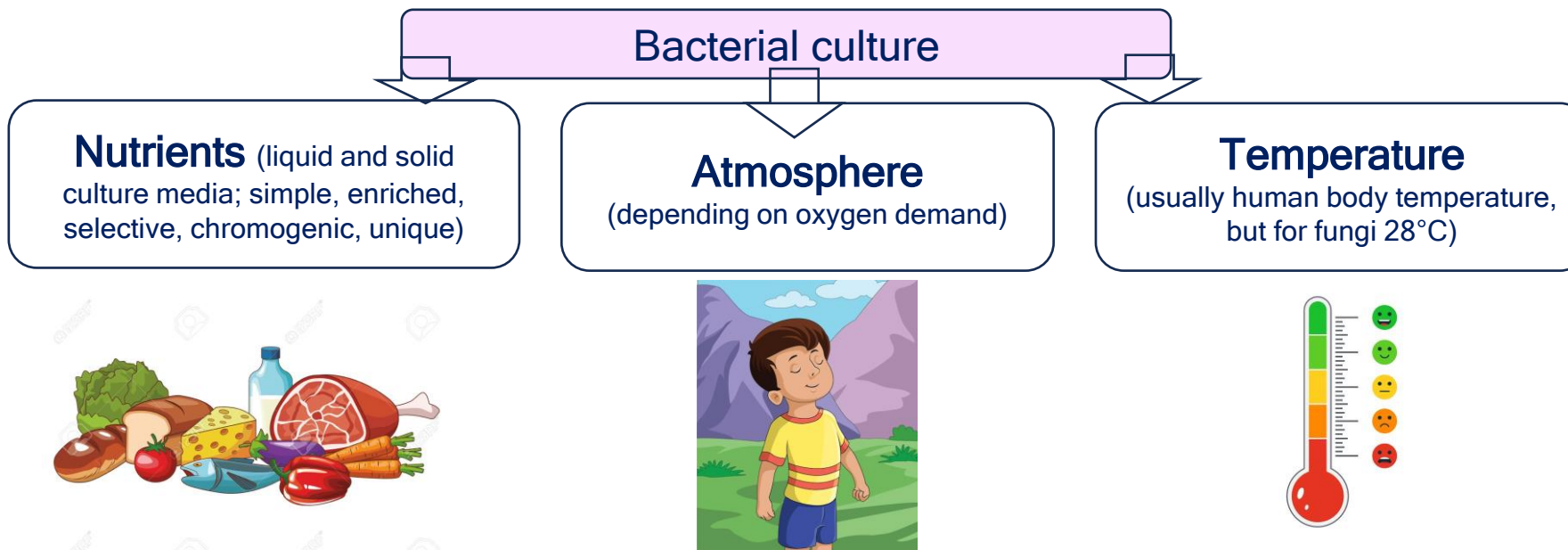


# Surface structures

- a) **Cilia** (long protein protrusions present in many bacteria) - movement in an aqueous or gel environment (e.g. mucus) = taxis
- b) **Fimbriae** (short protein spikes present in many bacteria) - adhesion and exchange of genetic material (sexual fimbriae)



# Laboratory diagnosis



**Isolation and identification of the pathogen - the gold diagnostic standard**

It allows us to determine sensitivity to antibiotics - targeted, effective treatment

# Laboratory diagnosis

## Nutritional requirements - culture

### Uncultivable

Treponema,  
Mycobacterium leprae

Difficult diagnosis,  
Diagnostic techniques  
different than culture

Leki z wyboru

### Undemanding

Simple culture media  
(supplemented with glucose)  
Microorganisms capable of  
surviving in the environment

Bacilli, rods, Staphylococcus,  
enterococci, Listeria

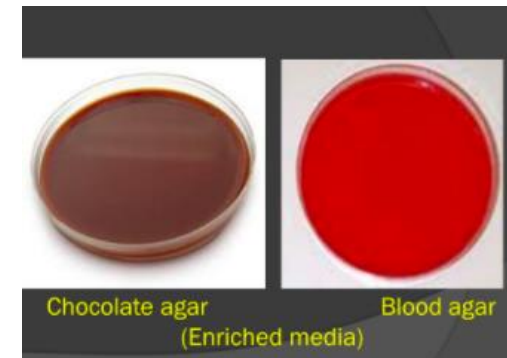
### Demanding

Enriched media (supplemented  
with blood, serum, vitamins, etc.)  
Microorganisms are most often  
unable to survive in the  
environment or for a short period  
of time

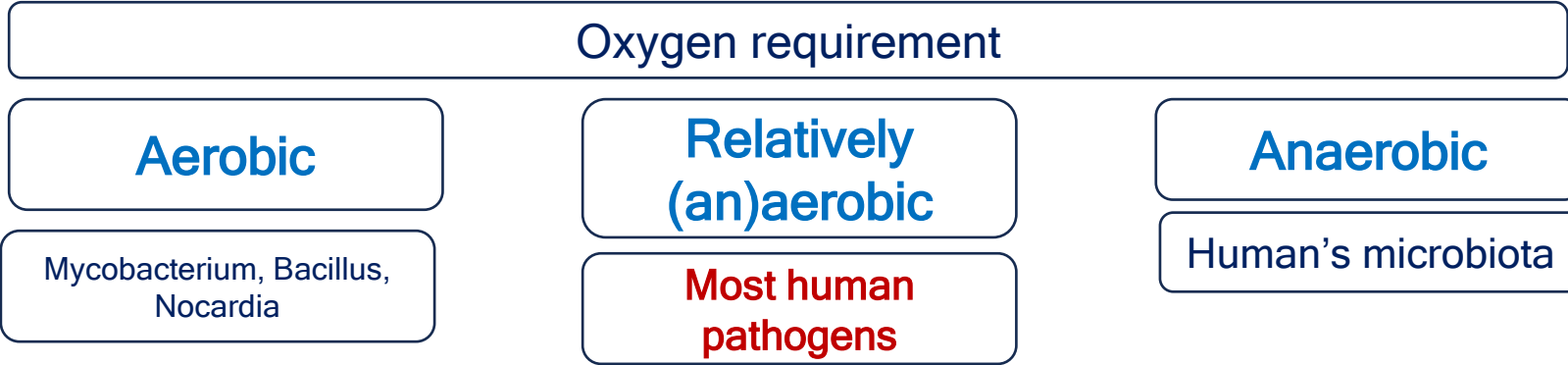
Streptococci, anaerobes,  
meningococci, mycoplasmas,  
hemophilic rods, Bordetella

**Selective media** - a selection factor (e.g. antibiotic,  
chemical compound) - inhibits the growth of most  
microorganisms, but does not affect the one we are looking  
for. E.g., SS medium for Salmonella & Shigella

**Chromogenic media** - growth in a specific color





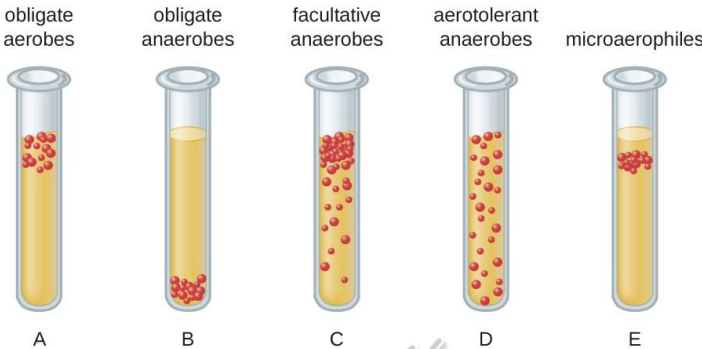


### The importance of familiarity

- 1. Pathomechanism of infection (region of the body: large body vs. skin; abscess vs. open wound; chronic vs. acute infections)
- 2. Empirical treatment
- 3. Samples for research - referral/direction of research

Temperature requirements - varied

Human body temperature - human pathogens



## Culture of biological samples from patients in the laboratory

The laboratory technician does not see the patient  
and does not know the symptoms of the disease

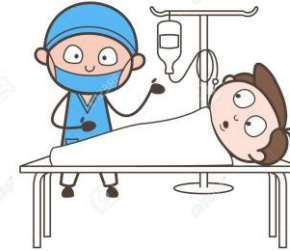
## General (no indication of the direction of research)

Routine culture media for the most common human pathogens



## Targeted - indicating the direction of the examination based on clinical symptoms

Enriched culture media, selective for the desired pathogen



No treatment, wrong  
treatment, further diagnostics  
Patient - risk of complications

False negative result!

Positive results!

Directed treatment

Curing the patient

**Without an indication of suspicion** - routine culture:  
Mac Conkey's medium for enteric bacilli and selective  
medium for Salmonella, Shigella

What will grow? Enteric bacilli: E. coli, Salmonella,  
Shigella, Klebsiella etc. - **but not Campylobacter!**

**Indication of suspicion** - inoculation on media dedicated  
to Campylobacter culture

**Campylobacter!** (if the doctor's suspicion was correct)

## Stool culture

from a patient with  
suspected  
campylobacteriosis



## Student knows:

1. What is the difference between the cell walls of Gram-positive (GP) and Gram-negative (GN) bacteria?
2. What role do cell wall antigens LPS and LTA play in infections caused by GP and GN bacteria?
3. What role do the most essential structures of a bacterial cell play in infections (envelope, glycocalyx, adhesins: proteins and fimbriae, cilia, spores)
4. How do differences in the oxygen requirements and nutrients affect the doctor's decision about empirical treatment, the type of material collected from the patient, and the results of bacteriological examination?
5. Knows and understands the terms from the dictionary on the first slide



A scanning electron micrograph (SEM) showing a highly textured, porous surface. The surface is covered in a dense network of fine, wavy lines and ridges. Several large, circular, dark openings or pores are visible, some of which are interconnected. The overall appearance is that of a complex, organic or synthetic material structure.

*What is this?*



UNIWERSYTET MEDYCZNY  
IM. PIASTÓW ŚLĄSKICH WE WROCŁAWIU

# Thank you for your attention

W celu uzyskania szczegółowych informacji na temat prezentowanych treści  
proszę o przesłanie wiadomości na adres mailowy:

[beata.sobieszczanska@umw.edu.pl](mailto:beata.sobieszczanska@umw.edu.pl)